# Bulk Hydrogen Storage

Strategic Directions for Hydrogen Delivery Workshop

*May 7-8, 2003*

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# Main Themes/Caveats

- Bulk Storage = Anything not on the vehicle
  - 10's of Tons -- End use point
  - 50-100 Tons – Terminals/City Gates
  - 1000's Tons – Between Production Facility and Terminal/City Gate
- Bulk storage requirements less restrictive and different from on-board storage
- Uncertainty about evolution of infrastructure requires multiple pathways to be considered

***Bulk storage is an economic solution to address supply/demand imbalance***

# Targets/Objectives

- Hard to quantify – scenario & end-use dependent
- Storage Materials (solid state) and container require different  targets
- Cost – Capital, Operating
- Performance – Capacity, Footprint, Leak rates, Safety

# Priority Barriers

- 5 Category Headings:
  - **Bulk Storage Economics**
  - **Storage Performance Issues**
  - **Market and Institutional Issues**
  - **Storage Devices and Technologies**
  - **Infrastructure Definition – Interplay of Storage within the "Bigger Picture"**
- Lack of Systems Optimization Analysis and Models to permit Optimization
- Leak Detection – will require Sensors, odorants, etc. to address Leaks (Safety Concerns)
- Lack of Codes/Standards to Address End Use Requirements
- Lack of Solid-phase Bulk Storage that is robust and economic (initial cost and life cycle issues)
- Lack of knowledge of $H_2$ interaction in Geologic Formations.

# RD&D Needs

- Top 6 Categories:
  - **Advanced Concepts**
  - **Advanced Materials**
  - **Codes & Standards**
  - **Studies & Analyses**
  - **Tools & Techniques**
  - **Demonstration & Testing**

# RD&D Activities

- Top 6 Activities:
  - **Develop Manufacturing Technologies for H.P. Tanks in large numbers of units and low cost.**
  - **Search for inexpensive solid materials for low pressure storage --- Weight is not a critical design parameter for bulk storage (vs. on-board)**
  - **Develop new materials to address unique $H_2$ leakage and Embrittlement Considerations**
  - **Develop Smart Sensors and odorants to be used for Leak Detection**
  - **Fund robust Systems Analysis and Modeling Programs to define the R&D Infrastructure Landscape**
  - **Develop Geologic Storage Technologies and Model $H_2$ storage in Various Geologic Formations.**

# “Take home” messages

- **Economics**

  Cost of Storage vis-à-vis a “no storage” infrastructure

- **Safety**

  Leak Detection is a Critical Issue for Safety and to promote Consumer Confidence

- **Lack of Infrastructure Definition**

  The type(s), quantity, operating parameters (pressure ranges, temperatures, cycling, etc.) of Storage will be dictated by the development of the surrounding production, consumption and delivery infrastructure.